CLAIMS

What is claimed is:

1. A tandem time-of-flight mass spectrometer comprising:

a) a pulsed source of ions that focuses ions of a predetermined mass-to-charge ratio range onto a focal plane;

b) a timed ion selector positioned at the focal plane to receive the focused ions from the pulsed sources of ions, wherein said timed ion selector permits only the ions of the predetermined mass-to-charge ratio range to travel to the ion fragmentor;

c) an ion fragmentor in communication with said timed ion selector;

d) a timed pulsed extractor coupled to said ion fragmentor, wherein the timed pulsed extractor accelerates the predetermined ions and fragments thereof; and

e) a time-of-flight analyzer in communication with the timed pulsed extractor, wherein said time-of-flight analyzer determines the mass-to-charge ratio of the preselected ions and fragments thereof.

2. The mass spectrometer of claim 1 wherein the timed pulsed extractor is coupled to said ion fragmentor by a substantially field free region, said field free region allowing the ions excited by collisions in the ion fragmentor to substantially complete fragmentation.

3. The mass spectrometer of claim 2 further comprising an ion guide positioned in the substantially field free region.

4. The mass spectrometer of claim 3 wherein said ion guide comprises a guide wire.

5. The mass spectrometer of claim 3 wherein said ion guide comprises a plurality of apertured plates with a positive DC potential applied to every other plate of said plurality of plates and a negative DC potential applied to the intervening plates of said plurality of plates.

6. The mass spectrometer of claim 3 wherein said ion guide comprises an RF excited multipole lens.

7. The mass spectrometer of claim 1 further comprising a grid positioned between the ion fragmentor and the timed pulsed extractor, said grid being biased to produce the substantially field free region.

8. The mass spectrometer of claim 1 wherein said timed ion selector comprises a drift tube and a timed ion deflector.

9. The mass spectrometer of claim 8 wherein said drift tube includes an ion guide.

10. The mass spectrometer of claim 9 wherein said ion guide comprises a guide wire.

11. The mass spectrometer of claim 9 wherein said ion guide comprises a plurality of apertured plates with a positive DC potential applied to every other plate of said plurality of plates and a negative DC potential applied to the intervening plates of said plurality of plates.

12. The mass spectrometer of claim 9 wherein said ion guide comprises an RF excited multipole lens.

13. The mass spectrometer of claim 8 wherein said timed ion deflector comprises a pair of deflection electrodes to which a potential difference is applied, said potential preventing ions from reaching the ion fragmentor except during the time interval in which ions within the selected mass-to-charge ratio range pass between the electrodes.

14. The mass spectrometer of claim 8 wherein said timed ion deflector comprises two pairs of deflection electrodes, wherein a potential difference is applied to the first pair of deflection electrodes to prevent ions of lower mass-to-charge ratio from reaching the ion fragmentor and a potential difference is applied to the second pair of deflection electrodes to prevent ions of higher mass-to-charge ratio from reaching the ion fragmentor.

15. The mass spectrometer of claim 1 wherein said pulsed source of ions comprises a matrix-assisted laser desorption/ionization (MALDI) ion source with delayed extraction.

16. The mass spectrometer of claim 1 wherein said pulsed source of ions comprises an injector that injects ions into a field-free region and a pulsed ion extractor that extracts the ions in a direction that is orthogonal to a direction of injection.

17. The mass spectrometer of claim 1 wherein an energy of the ions entering the ion fragmentor is controlled by applying an electrical potential to said ion fragmentor.

18. The mass spectrometer of claim 1 wherein said ion fragmentor comprises a collision cell wherein ions are caused to collide with neutral molecules.

19. The mass spectrometer of claim 1 wherein said ion fragmentor comprises a photodissociation cell wherein ions are irradiated with a beam of photons.

20. The mass spectrometer of claim 1 wherein said ion fragmentor comprises a surface dissociation means wherein ions collide with a solid or liquid surface.

21. The mass spectrometer of claim 1 wherein said mass analyzer comprises a drift tube coupling said timed pulsed extractor to an ion detector.

22. The mass spectrometer of claim 21 wherein said drift tube includes an ion guide for increasing the efficiency of ion transmission.

23. The mass spectrometer of claim 22 wherein said ion guide comprises a plurality of apertured plates with a positive DC potential applied to every other plate of said plurality of plates and a negative DC potential applied to the intervening plates of said plurality of plates.

24. The mass spectrometer of claim 22 wherein said ion guide comprises an RF excited multipole lens.

25. The mass spectrometer of claim 21 wherein an ion mirror is interposed between said drift tube and said detector.

26. The mass spectrometer of claim 1 wherein said timed pulsed extractor comprises a delayed extraction ion source for said mass analyzer whereby ions are focused in time so that ions of each mass-to-charge ratio arrive at the detector within a narrow time interval independent of their velocity when exiting the ion fragmentor.

27. The mass spectrometer of claim 1 wherein said pulsed source, said timed ion selector, and said ion fragmentor are contained within a same vacuum housing.

28. A method for high performance tandem mass spectroscopy comprising the steps of:

a) producing a pulse of ions from a sample of interest;

b) focusing ions from the pulse that have a predetermined mass-to-charge ratio range into an ion selector;

c) activating the ion selector thereby selecting the focused ions having the predetermined mass-to-charge ratio range;

d) exciting the selected ions thereby fragmenting the ions; and

e) analyzing said fragment ions using time-of-flight mass spectrometry.

29. The method of claim 28 wherein the step of analyzing said fragment ions using time-of-flight mass spectrometry comprises analyzing said fragment ions using delayed extraction time-of-flight mass spectrometry

30. The method of claim 28 further comprising the step of passing said excited ions through a nearly field-free region thereby allowing said excited ions to substantially complete fragmentation therein.

31. The method of claim 28 wherein the step of exciting said selected ions comprises colliding the ion with neutral gas molecules.

32. The method of claim 28 wherein the step of producing the pulse of ions comprises a method selected from the group consisting of: electrospray, pneumatically-assisted electrospray, chemical ionization, MALDI, and ICP.

33. A tandem time-of-flight mass spectrometer comprising:

a) a pulsed source of ions;

b) a timed ion selector positioned to receive ions from the pulsed sources of ions, wherein said timed ion selector permits only the ions of the predetermined mass-to-charge ratio range to travel to the ion fragmentor;

c) an ion fragmentor in communication with said timed ion selector;

d) a timed pulsed extractor coupled to said ion fragmentor by a substantially field free region, wherein the timed pulsed extractor accelerates the predetermined ions and fragments thereof; and

e) a time-of-flight analyzer in communication with the timed pulsed extractor, wherein said time-of-flight analyzer determines the mass-to-charge ratio of the preselected ions and fragments thereof.

34. The mass spectrometer of claim 33 wherein the substantially field free region permits the ions excited by collisions in the ion fragmentor to substantially complete fragmentation.

35. The mass spectrometer of claim 33 further comprising a grid positioned between the ion fragmentor and the timed pulsed extractor, said grid being biased to produce the substantially field free region.

36. The mass spectrometer of claim 33 wherein said timed ion selector comprises a drift tube and a timed ion deflector.

37. The mass spectrometer of claim 33 wherein said pulsed source of ions comprises an injector that injects ions into a field-free region and a pulsed ion extractor that extracts the ions in a direction that is orthogonal to a direction of injection.